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(54) **POLYMERIC MATRICES FORMED FROM MONOMERS COMPRISING A PROTECTED AMINE GROUP**

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(58) **Field of Classification Search**

CPC C08G 69/32; C08G 69/42
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,761,234 A	8/1988	Uemura et al.	
4,828,708 A	5/1989	Bray	
5,321,162 A *	6/1994	Kim	560/317
6,837,996 B2	1/2005	Kurth et al.	
2008/0296225 A1*	12/2008	Ho	210/640

FOREIGN PATENT DOCUMENTS

CN	101254417 A	9/2008
GB	1246168 A	9/1971

JP	62121603 A	6/1987
JP	62176506 A	8/1987
JP	10165790 A	6/1998
JP	2004050144 A	2/2004
JP	2004255368 A	9/2004
JP	2006198461 A	8/2006

OTHER PUBLICATIONS

Tang et al., Probing the nano- and micro-scales of reverse osmosis membranes; *J. Mem. Sci.*, 287 (2007), 146-156.

Jin et al., Effects of polymerization conditions on hydrophilic groups in aromatic polyamide thin films; *J. Membr. Sci.* 330 (2009) 175-179.

Nadler et al., Molecular simulation of polyamide synthesis by interfacial polymerization; *J. Membr. Sci.* 315 (2008) 100-105.

Cahill, et al., Microscopy and microanalysis of reverse-osmosis and nanofiltration membranes; *MRS Bulletin*, 33 (2008), 27-32.

Kim et al., Positron annihilation spectroscopic evidence to demonstrate the flux-enhancement mechanism in morphology-controlled thin-film-composite (TFC) membrane; *Environ. Sci. Technol.*, 39 (2005) 1764-1770.

Freger, Viatcheslav, Nanoscale heterogeneity of polyamide membranes formed by interfacial polymerization, *Langmuir* 19 (2003) 4791-4797.

Kwolek et al., Synthesis, anisotropic solutions, and fibers of poly(1,4-benzamine), *Macromolecules*, 1977, 10 (6), 1390-1398.

Kim, Young H., Lyotropic liquid crystalline hyperbranched aromatic polyamides, *J. Am. Chem. Soc.*, 1992, 114 (12), 4947-4948. Search Report and Written Opinion from corresponding PCT Application No. PCT/US2011/058765 dated Jan. 30, 2012.

Huber, T. et al., "New Hyperbranched Poly(Ether Amide)s Via Nucleophilic Ring Opening of 2-Oxazoline-Containing Monomers", *Macromolecular Chemistry and Physics*, vol. 200, No. 1, pp. 126-133, Jan. 1, 1999.

Chiang, Y. C. et al., "Nanofiltration membranes synthesized from hyperbranched polyethyleneimine", *Journal of Membrane Science*, vol. 326, No. 1, pp. 19-26, Jan. 5, 2009.

Unofficial Manual Translation of Chinese Office Action issued in connection with corresponding CN Application No. 201180062008.5 on Sep. 19, 2014.

Thomas Huber et al. New Hyperbranched Poly(ether amide)s via Nucleophilic Ring Opening of 2—oxazoline—containing Monomers, *Macromolecular Chemistry and Physics*, 200, Dec. 13, 1991. Yen-Che Chiang et al., Nanofiltration Membranes Synthesized from Hyperbranched Polyethyleneimine, *Journal of Membrane Science*, vol. 326, Issue 1, Jan. 5, 2009, pp. 19-26.

Unofficial English translation of Japanese Office Action issued in connection with corresponding JP Application No. 2014521607 on Nov. 17, 2015.

Toyobo Co Ltd et al., English language abstract of JP62176506, published Aug. 3, 1987.

(Continued)

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(57)

ABSTRACT

The present disclosure relates to polymeric matrices composed of protected amine compound residues and membranes composed from such polymeric matrices. In particular, the present disclosure relates to a polymeric matrix comprising amine compound residues, acyl compound residues and protected amine compound residues.